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The Elements of Sovereign Debt Sustainability Analysis

Martin Guzman



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About the Author

Martin Guzman is a senior fellow with the Global Economy Program. He is contributing to CIGI's ongoing research on sovereign debt restructuring.

Along with his CIGI appointment, Martin is a research associate at Columbia University Graduate School of Business, where he is a member of the Institute for New Economic Thinking Research Group on Macroeconomic Instabilities and Inefficiencies, and a co-chair of Columbia University's Initiative for Public Dialogue Taskforce on Debt Restructuring and Sovereign Bankruptcy. He is also associate professor at the University of Buenos Aires.

Martin holds an M.A. and Ph.D. in economics from Brown University (Rhode Island), as well as a B.A. and M.A. in economics from the Universidad Nacional de La Plata, in Argentina. He has conducted extensive research on macroeconomics and debt crises, and has been published in several edited books and journals. His research has been prominently featured in the international media in outlets as *The New York Times*, Bloomberg, *The Washington Post* and *The Guardian*, among others. His articles have been translated into more than a dozen languages.

Martin is a recognized international expert on sovereign debt crises. He has presented to academics, practitioners and policy makers around the world. He has been called to present the findings of his research on Puerto Rico's debt crisis at the US Congress. He has also advised the United Nations General Assembly on issues of sovereign debt restructuring and their implications for economic development.

At CIGI, Martin's research on Argentina's 2001 default and restructuring, as well as his investigation on frameworks for improving sovereign debt restructuring outcomes, will inform CIGI's ongoing investigation of, and policy recommendations for, sovereign debt restructuring mechanisms.

About the Global Economy Program

Addressing limitations in the ways nations tackle shared economic challenges, the Global Economy Program at CIGI strives to inform and guide policy debates through world-leading research and sustained stakeholder engagement.

With experts from academia, national agencies, international institutions and the private sector, the Global Economy Program supports research in the following areas: management of severe sovereign debt crises; central banking and international financial regulation; China's role in the global economy; governance and policies of the Bretton Woods institutions; the Group of Twenty; global, plurilateral and regional trade agreements; and financing sustainable development. Each year, the Global Economy Program hosts, co-hosts and participates in many events worldwide, working with trusted international partners, which allows the program to disseminate policy recommendations to an international audience of policy makers.

Through its research, collaboration and publications, the Global Economy Program informs decision makers, fosters dialogue and debate on policy-relevant ideas and strengthens multilateral responses to the most pressing international governance issues.

Executive Summary

Debt sustainability analyses (DSAs) are generally done in contexts of distress that feature large revisions of pre-established perceptions. Those contexts are usually largely uncertain. Much of the information from the past becomes obsolete as a guide for forecasting the debtor's payment capacity. In those environments, there is not an obvious superior approach for assessing sovereign debt sustainability. However, there are elements that must be part of the analysis regardless of the chosen approach. This paper offers clarifications on the foundations of a DSA and the elements that constitute it. It is argued that any framework for DSA must take three elements into account: First, the framework for DSA has to define the relevant constraints for assessing what is a state of sustainable debt. Second, it must define a model for projecting the capacity for stabilizing debt that incorporates the relevant endogenous feedback effects associated with the implementation of fiscal and debt policies. Third, it has to make assumptions about the distribution of shocks that affect the capacity of debt payment and has to deal with the heterogeneity of beliefs that underlie any DSA. The paper discusses the practice of DSA and how those elements are dealt with and analyzes the interplay between those three elements in an analysis of debt sustainability.

Introduction

Sovereign debt sustainability refers to the capacity of a sovereign debtor to meet its debt commitments. The study of sovereign debt sustainability is important for at least two reasons. First, an excessive debt burden has negative effects on macroeconomic performance — an inefficient outcome, per se, that jeopardizes social and economic development and deteriorates the

creditors' expected recovery rates.¹ Second, as sovereigns generally borrow in international credit markets, situations of sovereign debt distress have cross-border effects that undermine the stability of the global economy, which explains, in part, why multinational institutions pay significant attention to sovereign debt issues.²

Assessing the sovereign's debt stabilization capacity, which is determined by its capacity to achieve surpluses, is a complex exercise.³ There is an ambiguity in the definition of "feasible" primary fiscal surpluses. The primary fiscal surplus is the difference between the tax revenues and the primary government expenses, i.e., the expenses before interest payments. Thus, the definition of a feasible primary fiscal surplus requires, first, a definition of the minimum government expenses that can be tolerated, an issue that goes beyond economic considerations, and that requires assessing what is essential for a society; and second, it requires forecasts about future tax revenues, over which there are multiple layers of uncertainty. Those two issues are interrelated: changes in public spending affect economic activity, which, in turn, affects tax revenues — the magnitude of those effects is generally state-dependent and uncertain for the analyst performing a DSA. Thus, sustainability is a probabilistic concept, and its analysis is subjective, as it depends on the distributional assumptions that the analyst makes for the shocks that affect debt payment

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- 1 The theoretical literature identifies two mechanisms through which debt may affect economic performance. The first channel has to do with incentives. A high debt burden means that the benefits of actions that improve the economic performance of the debtor country will mostly be appropriated by the creditors. Thus, a high debt burden acts as a high marginal tax rate that discourages the debtor's effort (Krugman 1988a, 1988b; Sachs 1986, 1989). Besides, a high debt burden is associated with a need for larger primary fiscal surpluses, which, in turn, means that the necessary tax rates to satisfy the debtor's transversality condition will be higher. This discourages investment. The second channel has to do with aggregate demand effects. In an economy that suffers a recession, the debt burden of the public sector may have destabilizing effects on the aggregate economy. This happens when the public sector pursues fiscal austerity policies in order to meet debt payments, thus leading to decreases in aggregate demand that in an aggregate-demand-constrained regime have contractionary effects on the economic activity — depressing tax revenues and possibly even increasing the burden of debt in relation to output (see the revision of cases of fiscal adjustment over the recent history by Jayadev and Konczal 2010, 2015). The macroeconomic rationale for debt forgiveness is also analyzed by Geanakoplos (2014).
 - 2 The International Monetary Fund (IMF), for instance, has frameworks for DSA of market access and low-income economies. See www.imf.org/external/pubs/ft/dsa/.
 - 3 The task involves a level of complexity such that it has even been classified as "mission impossible" (Wyplosz 2011).

capacity. Situations of debt distress that are not quickly detected and properly addressed lead to delays in dealing with restructuring needs.⁴

This paper discusses the elements that must be part of a framework for DSA. It presents a general conceptual framework that incorporates some of the most recent progress in the literature on sovereign debt sustainability and offers insights for the practice of DSA. The next section defines the central questions of a DSA and reviews definitions of the debt sustainability concept. It is argued that any framework for DSA must take three elements into account: First, the framework for DSA has to define the relevant constraints for assessing what is a state of sustainable debt. Second, it must define a model for projecting the capacity for stabilizing debt that incorporates the relevant endogenous feedback effects associated with the implementation of fiscal and debt policies. Third, it has to make assumptions about the distribution of shocks that affect the capacity of debt payment and has to deal with the heterogeneity of beliefs that underlie any DSA. The paper discusses the practice of DSA and how those elements are dealt with and analyzes the interplay between those three elements in an analysis of debt sustainability.

4 The evidence suggests that debt relief has had beneficial economic effects for debtor countries. Carmen M. Reinhart and Christoph Trebesch (2016) examined the economic performance of debtor countries during and after sovereign debt relief operations for samples that cover the periods 1920–1939 for defaults on official (government to government) debt and 1978–2010 for emerging markets defaults with private creditors, and found that per capita GDP increased 11 percent for emerging markets and 20 percent for advanced economies during the five years following a restructuring that resulted in an exit from the state of default. On the other hand, they found that not every type of restructuring has been associated with improvements in economic performance: the effects are significant only in deals that involved face value reductions. Reprofitting deals, such as operations with maturity extensions and interest reductions, were not associated with improvements in economic performance. A case that stands out is West Germany's debt relief through the London Debt Agreement, which was indispensable for West Germany's successful performance after World War II (the case is analyzed by Galofré-Vilà et al. 2016). The management of the ongoing Greek debt crisis is on the other end of the spectrum — a case that has been analyzed by Bulow and Geanakoplos (2017); Geanakoplos (2014); Goodhart, Peiris and Tsomocos (2018); Roubini (2011); Schumacher and di Mauro (2015); and Varoufakis (2016), among others.

The Concept of Debt Sustainability

The Probabilistic Nature of the Concept

There is a parallel between the concept of unsustainable debt for a sovereign debtor and the concept of insolvency for a corporation, but there are fundamental differences between them.

The concept of insolvency for a corporation is well-defined: a corporation is insolvent if the value of its liabilities is larger than the value of its assets, i.e., its net worth is negative. On the other hand, the analysis of sovereign debt sustainability does not focus on the debtor's net worth, but on its capacity to generate surpluses in order to meet debt payments. This is equivalent to asking whether the public sector has the capacity to satisfy its intertemporal budget constraint (IBC) without resorting to default.⁵ But given that the stream of surpluses is *ex ante* uncertain, it cannot be said that the debt position of a sovereign is sustainable or unsustainable as it can be said that a corporation is solvent or insolvent. Instead, sustainability statements are probabilistic.

Sovereign debt sustainability assessments are forward-looking exercises. There are multiple possible trajectories for the debtor's primary surplus, which will depend not only on its actions but also on events that are exogenous to the debtor. The practice of DSA require judgements on events that will happen in the future and over long horizons.

Debt Sustainability and Incomplete Markets

If there were complete debt contracts, there would be no sustainability problems. Each contingency would be contemplated and implicitly resolved in the debt contract, and the specification of the structure of contracts would be consistent — i.e., all budget constraints would be satisfied in all states of nature. The sustainability problem arises when there is an aggregate inconsistency: there are states

5 The satisfaction of the IBC without restoring to debt default is equivalent to the satisfaction of the debtor's transversality condition. This does not require full payment of the outstanding debt, but simply that the present value of debt converges to zero — a condition that is satisfied if the debt is stabilized with respect to a measure of payment capacity.

of nature in which there is an inconsistency between what the contract stipulates and the satisfaction of the budget constraints. There are simply not enough resources to fulfill all promises.⁶ This means that sovereign bonds that are often labelled as non-contingent bonds are actually contingent — payments are non-contingent only in the region of the probability distribution in which there is no default.

The Identification of the Feasible Primary Fiscal Surpluses

The sovereign's capacity to satisfy its transversality condition — which ensures the satisfaction of the IBC without a debt default — is intrinsically related to its capacity to achieve primary fiscal surpluses.⁷ But there is an ambiguity in the definition of the available stream of fiscal surpluses: not the entire stream of fiscal revenues is available for debt service. Instead, it is generally unclear what fraction of that stream can be used for debt service, and what fraction *must* be used for government spending. The identification of *feasible* primary fiscal surpluses requires an identification of the minimum fiscal spending that can be tolerated, an issue that depends on economic, political and social considerations. This is often a source of discrepancies between the debtor and the creditors in episodes of debt restructuring — with the debtor often claiming that the cuts to public spending that can be tolerated are lower than what the creditors demand.⁸ More generally, the definition of debt payment capacity may go beyond economic considerations, and may instead be dependent on the definition of other constraints that are meant to ensure that some basic principles for international debt markets are respected.

On the economic side, the identification of the feasible primary fiscal surpluses has to take into account that the revenues and the expenditures side are not independent: cuts to public spending have contractionary effects on economic activity that, in turn, decrease fiscal revenues.

6 The study of macroeconomic debt crises is essentially the study of the macroeconomics of the broken promises (see Heymann 2009).

7 The precise form that the government's IBC takes will depend on the characteristics of the environment (as the degree of market incompleteness), the degree of risk aversion of lenders and the extent to which the government bonds can be used to hedge risks. See the analysis in Mendoza and Ostry (2008).

8 Those demands may even be incompatible with the respect for human rights, an issue analyzed, for instance, in Bohoslavsky (2016), Bohoslavsky and Goldman (2016), Guzman and Stiglitz (2016b), Raffer (1990) and Salomon (2015).

The Relevant Debt Stock

The identification of the relevant debt stock is often a non-trivial matter. The analyst performing a DSA faces the difficult challenge of assessing contingent liabilities for a sovereign debtor, taking into account that debts that do not originate in the public sector may eventually be added to the stock of public debt, for instance, due to government bailouts of financial or non-financial entities in the private and the public sector.⁹

DSAs: Different Literatures, Different Meanings

The analysis of debt sustainability has been approached from different angles in the literature. The empirical literature on the sustainability of fiscal policies, which has its origins in Bohn's work (Bohn 1995; 2007; 2008) describes conditions that are sufficient for fiscal sustainability. That literature tests whether past fiscal policies can be sustained over time in a way that satisfies the government's transversality condition under general equilibrium conditions that link the government and the private sector.¹⁰ This approach refers to a concept of fiscal sustainability that focuses on past behaviours. While those tests are helpful to detect policy behaviours that are unsustainable, they do not indicate whether there is a future feasible course of policies that would be consistent with a state of sustainable debt. Thus, this approach is insufficient for providing a complete analysis of the sustainability of a debt position. This limitation is well recognized in the literature (see, for example, D'Erasmus, Mendoza and Zhang 2016; Wyplosz 2011).

On the other hand, the analysis of debt sustainability in times of distress performed by institutions such as the IMF focuses on situations where fiscal policies were already unsustainable, and — recognizing the need for policy shifts — it intends to provide answers on whether there is an alternative

9 A notable case in this respect was the nationalization of private debts by Latin American countries in the 1980s in the context of the Latin American debt crisis (see Ocampo 2014). Credit rating agencies pay attention to contingent liabilities in their assessment of sovereign credit risk. Both Standard and Poor's and Moody's take into account contingent liabilities in their assessments. See Standard and Poor's (2006) and Moody's (2008).

10 This means that the discount factors used to discount future streams have to be equilibrium prices that do not necessarily coincide with the interest rate on public debt. More specifically, the relevant discount factor will depend on the degree of risk aversion of lenders, as well as the correlation between future government surpluses and the marginal utility of consumption (see Mendoza and Ostry 2008).

path of feasible policies that could ensure that debt is sustainable with high probability.

The Relationship between Public Debt and External Debt Sustainability

Governments often borrow in foreign currency. The government's capacity to collect revenues in foreign currency depends, *inter alia*, on the value of the exchange rate. Thus, the sustainability of the debt of a public sector that is indebted in foreign currency is related to the sustainability of the country's current account balance.

Rollover Risk

Debts are generally rolled over. This entails an additional risk that a DSA must take into account: the risk that borrowing costs change. In extreme situations, where the debtor loses all access to credit markets, it becomes impossible to refinance debts. This risk, often referred to as liquidity risk, is related to changes in perceptions about the sustainability of the debt position. While, at times, the concepts of liquidity and solvency are treated as separate concepts, that dichotomy is misconceived. If there was a perception of debts being sustainable with high probability, there would be no illiquidity.

Multiple Equilibria

The collective process of forming of expectations that underlies the market's assessments of debt sustainability can lead to multiple equilibria. The perception that debts are sustainable with high probability translates into a low interest rate that, in turn, makes full debt payment a more likely outcome. On the other hand, fears of unsustainable debt lead to higher borrowing costs that validate the perceptions of unsustainability. Thus, debt distress can be self-fulfilling.¹¹

This imposes a challenge for the analysis of debt sustainability of institutions that can influence market outcomes, like the IMF. On the one hand, a flawed DSA by such an institution may affect debt sustainability per se — for instance, the judgment of a debt position as not *sustainable with high probability* when it would be sustainable with high probability under a low interest rate may lead to a high market interest rate that validates the perception of unsustainability. On the other

hand, the issue raises unsettling questions on what rates the institution performing a DSA should use to discount future flows. Performing a DSA entails the recognition that markets are not efficient — otherwise it would suffice to look at the market risk premium as a measure of debt sustainability. If the analyst performing the DSA has a more optimistic view than the market on the debtor's capacity to obtain future surpluses, but uses market prices to discount those flows, it will make assessments that will be biased by market perceptions — perceptions that in the analyst's view are not well founded. But if the market interest rate is the relevant rate at which the borrower refinances its debts, not using that rate as the relevant discount factor would lead to a flawed assessment of the debtor's capacity to sustain its debts. There is not an obvious solution to this quandary other than simply accepting the limitations of a DSA (see Guzman and Heymann 2015 and Wyplosz 2011 for a more extensive analysis).

The Central Questions of a DSA

Any DSA must address the following questions:

- Is debt sustainable with high probability?
- If it is not, what is the size of debt relief that would take it to a sustainable position with high probability?

Answering the first question requires a definition of the constraints that determine the level of debt that is “sustainable,” as well as a measure of “high probability.”

Economic theory does not yet offer fully articulated models for the determination of the optimal probability of debt sustainability. However, it does offer some valuable intuitions. First, the choice of a probability measure with which debt sustainability must be satisfied should be related to the relationship between debt and macroeconomic performance. In this respect, there will be a probability of debts being unsustainable beyond which debt triggers a destabilizing macroeconomic dynamic, or that even decreases the expected value of creditors' recovery (as the peak of the Laffer curve in Krugman 1988b), which constitutes an inefficiency. Second, that measure of high probability will also depend on the distribution of probability of shocks, which will generally be country specific, as well as on the society's risk aversion. For a country with a

¹¹ See, for instance, Calvo (1988) and Ayres et al. (2018).

large variance of shocks, such as a small island that is often hit by natural disasters or that is too dependent on the price of a commodity, demanding a very low probability of default will imply that the debt that can be sustained will be “too low” — so low that valuable opportunities that require external financing would be forgone. That might be inefficient — both the debtor and the creditors might find it beneficial to sign debt contracts that include a larger risk premium that recognizes a higher probability of default.

The Definition of the Relevant Constraints

The assessment of debt payment capacity requires a definition of the constraints that determine how much the debtor can pay. Each of those constraints constitutes a necessary condition for debt sustainability. The standard analysis refers to constraints of a purely economic nature as the debtor’s transversality condition, which refers to the long-term debt payment capacity, as well as short-term financing constraints. A recent branch of the literature also points out the importance of satisfying other constraints at the time of debt restructuring processes — constraints that can be of an economic, legal and social nature and that are meant to ensure a *proper* functioning of sovereign lending markets.

The Debtor’s Transversality Condition

The debtor’s transversality condition associated with one trajectory of states is satisfied if, and only if, the debtor’s IBC can be satisfied without a debt default in that trajectory. While, at times, programs that aim at ensuring debt sustainability include the goal of short-term debt stabilization, there may be multiple paths of fiscal policies, including paths that entail an increasing debt burden in the short term followed by a stabilizing debt burden, that are compatible with the satisfaction of the transversality condition.

Under the satisfaction of the transversality condition, the debtor’s IBC states that the value of outstanding debt must be equal to the present discounted value of the revenues that the debtor

generates net of its expenses. The definition of the debtor’s IBC associated with a transversality condition is not a trivial matter; there are at least two important caveats that must be taken into account at the time of defining the IBC. First, lenders’ perceptions of the safety of government bonds vary across countries; those sovereigns that issue bonds that the lenders value as insurance vehicles could run negative surpluses on average and still satisfy the transversality condition. Second, sovereign governments can finance parts of their spending through seigniorage, either by appropriating resources from the private sector through inflation tax or as a result of an increase in the demand for real balances. This is another element that may make it possible for a debtor to satisfy its transversality condition at the same time that it runs primary deficits on average. There is, of course, a limit to this source of funding, as the tax base may shrink as inflation accelerates, taking the economy eventually to the right side of the peak of the Laffer curve.

Constraints Based on Principles for Sovereign Debt Restructuring

There is a growing literature that postulates that sovereign debt restructuring processes must respect principles that ensure that sovereign lending markets are *ex ante* and *ex post* efficient,¹² and, more generally, that the workings of sovereign lending markets do not undermine the development prospects of countries in distressful situations, and that debt crises resolution processes are respectful of human rights.¹³

Although the debate on what principles would ensure a correct functioning of sovereign lending markets is still unsettled, there has been progress in recent years in understanding the rationale of different principles. The United Nations General Assembly (UNGA) and the United Nations Conference on Trade and Development have taken active roles in this debate. In 2015, the UNGA passed a resolution that defined nine principles that should be adopted as the basis of a multinational process

12 When commitment considerations become relevant, there may be trade-offs between *ex ante* and *ex post* efficiency. *Ex post* efficiency may lead to *ex ante* strategic behaviour that is inefficient.

13 See Raffer (1990); Bohoslavsky and Goldmann (2016); Li (2015); Goldmann (2016); Blankenburg and Kozul-Wright (2016); Gelpern (2016); Guzman and Stiglitz (2016a, 2016b); Guzman and Lombardi (2017); and Howse (2016), among others.

for sovereign debt restructuring (see Li 2016; Guzman and Stiglitz 2016b; Blankenburg and Kozul-Wright 2016). The literature offers insights on the meaning of some of those principles for practical purposes, such as good faith (Kolb 2006; Goldmann 2016), legitimacy (Lienau 2016), equitable treatment of creditors (Brooks et al. 2015), majority restructuring (International Capital Market Association 2014; IMF 2016; Gelper, Heller and Setser 2016), transparency and impartiality (Guzman and Stiglitz 2016b).¹⁴

The premise that there are principles that must be respected in sovereign debt restructuring processes has implications for the practice of DSA. Basically, the principles impose additional constraints for the assessment of sovereign debt sustainability. While the choice of principles may involve a degree of subjectivism, related to the fact that there may be different views on what is a *correct* functioning of sovereign lending markets and on the principles that would ensure that goal, the choice of principles requires a translation to constraints for debt sustainability that can be interpreted in economic terms. The imposition of principles-based constraints for assessing debt sustainability implies that, in general, the level of sustainable debt will be lower than the one that would be implied simply by the satisfaction of the debtor's transversality condition with certain probability.

Possible Clash between Constraints

Constraints to the types and volume of debt that can be restructured may clash with the principles. Suppose, for instance, that there is a portion x of the sovereign's debt stock that for some reason cannot be written off. In this case, it could be that the full payment of x leads to the violation of one or more of the restructuring

principles — for instance, paying x could entail a degree of austerity that could contract economic growth to an extent that violates some of the principles that are imposed for the restructuring process. While, at times, there is a reference to claims that cannot be restructured — those of the IMF, for instance, that in practice is treated as senior creditor,¹⁵ — from a purely economic viewpoint, the concept of debt that cannot be restructured is odd (noting that resource constraints come first, and there could simply be insufficient resources to ensure full payment of any debt that is a priori considered as non-restructurable). In some circumstances, the full service of those debts does indeed clash with basic social protections that the principles for sovereign debt restructuring may try to shield.

The Endogenous Feedback Effects

The interdependence between the two variables that define the debtor's primary surplus, revenues and spending, is central to any DSA. Changes in spending policies lead to changes in economic activity that, in turn, affect fiscal revenues. In order to make a proper assessment of the sustainability of a debt position, it is necessary to have information on the size of the multipliers that govern the mapping from public spending to economic activity, and from economic activity to fiscal revenues — the so-called fiscal multipliers. While assessing the size of fiscal multipliers for a particular economy under debt distress may not be doable at the time of a DSA, the empirical literature on fiscal multipliers provides useful information. Some of the findings from that literature are:

→ Spending multipliers are state-dependent: they are larger in recessions than in expansions (Auerbach and Gorodnichenko 2012a, 2012b; Blanchard and Leigh 2013).¹⁶

14 Countries are at times explicit about the principles that should be respected in a debt crisis resolution. For instance, Argentina's restructuring proposal following the default of 2001 was explicit about the priority of achieving sustainability in a way that did not undermine the country's recovery, and also explicitly announced that the restructuring proposal would treat creditors (official and private) differently (see Guzman 2016). The United Nations has advanced the agenda of setting general principles of international law for sovereign debt restructuring through a resolution that in September 2015 approved nine principles (the principles adopted by UNGA Resolution 69/319 are sovereignty, good faith, transparency, impartiality, equitable treatment of creditors, sovereign immunity, legitimacy, sustainability and majority restructuring; henceforth the "UN Principles"). For a discussion on the meaning of the principles, see Goldmann (2016); Bohoslavsky and Goldmann (2016); and Guzman and Stiglitz (2016b).

15 See Schadler (2014) for a more extensive analysis on the IMF preferred creditor status.

16 See also Chodorow-Reich (2017); Nakamura and Steinson (2014).

- There are negative endogenous feedback effects from fiscal contractions on tax revenues.
- Fiscal multipliers depend on the exchange rate regime: as predicted by economic theory, they are larger in economies that operate under fixed exchange rates than under flexible exchange rates (Ilzetki, Mendoza and Végh 2013).

While the empirical literature may provide guidance for thinking about the magnitude of the endogenous feedback effects associated with fiscal policies, there is always uncertainty about the values of the fiscal multipliers. This uncertainty has practical implications for DSA: it makes the sensitivity analysis with respect to the baseline assumptions of a DSA an especially important dimension of the exercise.

The endogenous feedback effects associated with fiscal policies can be accounted for by a macroeconomic model that defines explicitly the relationships between fiscal variables and economic activity. But this is not the exclusive (and not even the dominant) practice in DSA. Another possibility is to refer to the historical interdependence between fiscal variables and economic activity as the basis of the representation of those endogenous feedback effects. This is what the value-at-risk approach does. The last approach is the basis of the IMF fan charts.¹⁷ Its implementation can be illustrated as follows.

Suppose that we are performing a DSA for an economy under distress. Suppose that we want to compute the size of the primary fiscal surpluses that would ensure the satisfaction of the debtor's debt transversality condition. Let us define s as the value of the primary fiscal surplus as a ratio of GDP that stabilizes the debt-to-GDP ratio; s will depend (positively) on the current debt-to-GDP ratio, as well as (negatively) on the growth rate of output and (positively) on the interest rate. If debt (or part of it) is denominated in foreign currency, s will also depend on the evolution of the exchange rate. A distribution for the debt dynamics is obtained from the matrix of the statistical moments that define the joint distribution of the nominal or real GDP, the nominal or real interest rate, the variation in the exchange rate, and the primary fiscal surplus as a ratio of GDP. The distribution is chosen to match the first two moments of the historical distribution of those variables,

i.e., means, and variances and covariances. Those distributions of shocks are fed into the equation that governs the dynamic of the debt-to-GDP ratio in order to compute a distribution for the projected debt-to-GDP path. This baseline scenario may be modified to accommodate changes in policies or any relevant factor that may impact the joint distribution of shocks — modifications that define the alternative scenarios.

The fan chart analysis imposes that the debt- or primary-surplus-to-GDP ratio remains below an upper limit with some probability. The final step is to check that the required fiscal surpluses that satisfy the constraint for each debt path are *realistic*. The assessment of what is realistic is based on the past experiences of fiscal adjustments — i.e., based on an analysis of the magnitude of surpluses that countries managed to sustain over certain time ranges.

Despite its merits, this approach has a big disadvantage: it assumes that historical correlations are a good guide for assessing future macroeconomic dynamics, and that assumption is likely to be incorrect when an economy is experiencing an economic crisis that is associated with a change of regime, as is often the case in economies under debt distress for which a DSA is being performed. It is unlikely that a distribution of shocks that is obtained from a match between simulated moments and the moments from the actual data that correspond to a period of unsustainable growth represents accurately the actual interdependencies between the variables of interest for a DSA. To illustrate this problem with an example, take the case of Greece, a country that suffered a long-lasting economic crisis starting in 2007. Suppose that an analyst performs a DSA using a fan charts approach in 2008, and the joint distribution of shocks to the variables that determine the sustainability of Greece's debt position is chosen by matching historical moments for Greece. If Greece was experiencing an unsustainable macroeconomic dynamic during that historical period, the moments from that period will not be a reasonable representation of the Greek economy after market participants changed their perceptions. For instance, the correlation between GDP growth and other variables before the crisis was triggered will be largely unrepresentative of the same correlations after the crisis. Similarly, the relationship between fiscal policies and economic activity will capture situations that do not correspond to an economy in a deep recession, which would lead to an underestimation of the effects of

¹⁷ For details on the fan charts approach, see Celasun, Debrun and Ostry (2006). See also Consiglio and Zenios (2015) for an application of the value-at-risk approach to the analysis of sovereign debt sustainability.

contractionary fiscal policies. Such a DSA will likely underestimate the severity of the debt crisis, hence it will likely underestimate the need for debt relief.

The Stochastic Nature of the DSA

The analysis of debt sustainability requires making assumptions about the distributions of the relevant shocks. There is a subtlety related to how an analyst chooses to deal with the beliefs of market participants; this has direct implications for debt sustainability judgments. As pointed out in the discussion on multiple equilibria, the mere fact that an institution decides to perform a DSA entails the recognition that markets are not efficient. Otherwise, the DSA exercise would be irrelevant — it would just suffice to observe the market risk premium that would be perfectly pricing the risk associated with the debt position under analysis. Thus, the practice of DSA necessarily occurs in a context of heterogeneous beliefs, in which the distribution of shocks perceived by the analyst is different than the one that can be inferred from market prices. This raises the issue of how the analyst should incorporate the market beliefs into the DSA. If the analyst discounts the expected primary fiscal surpluses by using the market interest rate, their judgments will be influenced by beliefs that are different than their beliefs, which will tend, to some extent, to reproduce the market judgements on debt sustainability. For instance, if the analyst is more optimistic than the market about the perceived capacity of the debtor to service its debts, but discounts future flows by using the beliefs conveyed in market prices, they will conclude that debt is sustainable with a lower probability than what would correspond to their own perceptions about the capacity of the debtor to generate revenues in excess of expenses. This subtlety becomes even more important when the views of the analyst have practical consequences. This is clearly the case when it comes to the IMF DSA, as the IMF judgments may affect market prices and thus validate or invalidate the *ex ante* market perceptions on debt sustainability.

Apart from the issue of modelling beliefs, different approaches for DSA deal with the stochastic dimension of the analysis in different ways. In the risk management optimization approach,

sustainability analysis in each scenario is based on stress tests that require a risk measure that must be bounded. More generally, in an approach that defines explicitly the relevant constraints for the debtor, as well as the distributional assumptions on the shocks that enter those constraints, the probability of debt being sustainable will be equal to the probability that, given the distributions of shocks, all constraints are satisfied.

Debt Sustainability Assessments

An analysis of debt sustainability must put together the three elements described above — the definition of the relevant constraints, the consideration of the endogenous feedback effects associated with macroeconomic policies and the definition of the probability distributions for the relevant shocks, in order to answer the central questions of any DSA, i.e., is debt sustainable with high probability, and if it is not, what is the size of debt relief that would make it sustainable with high probability. A transparent description of how those three elements are taken into account would permit the identification of the sources of discrepancies in the results produced by different analytical approaches.

In any approach that accounts for the endogenous feedback effects of macroeconomic policies, as the primary fiscal surplus depends on the level of economic activity and the level of economic activity depends on fiscal policies, the primary fiscal surpluses that define the debtor's intertemporal budget constraints will be equilibrium objects that are mathematical fixed points.¹⁸ As the DSA is a prospective exercise that must consider multiple possible scenarios, the search for the fixed points must be made for each of the possible paths of scenarios.

The violation of the debtor's transversality condition in some scenarios is equivalent to the non-existence of feasible fixed points in those scenarios. When debt is "sufficiently" high, the necessary primary surpluses to satisfy the debtor's

¹⁸ Given the function that determines the value of the primary fiscal surplus, the value of the primary surplus will be an element of the domain of that function that is mapped to itself by that function.

transversality condition may be unfeasible. This happens when intending to force the economy to obtain the surpluses that would satisfy the IBC does not work. This is because of the contractionary effects that lead to a fall in fiscal revenues, that, in turn, leads to the need for more fiscal adjustments that depress the economy even more, creating a destabilizing dynamic that makes the generation of surpluses necessary for full debt payment simply unattainable — the so-called austerity trap.

If the approach for DSA includes constraints other than the debtor's transversality condition, in each of the scenarios in which there are feasible paths of fiscal surpluses that are consistent with the satisfaction of the debtor's transversality condition, it must also be checked that none of the other constraints are violated. Finally, the probability that debt is sustainable will be equivalent to the probability mass of possible scenarios for which there is a path of feasible primary fiscal surpluses that satisfy all the relevant constraints.

Conclusion

Analyses of debt sustainability are generally done in contexts of distress that feature large revisions of pre-established perceptions. Those contexts are usually largely uncertain. Much of the information from the past becomes obsolete as a guide for forecasting the debtor's payment capacity. The multipliers associated with macroeconomic policies become difficult to pin down. In those environments, there is not an obvious superior approach for assessing sovereign debt sustainability. However, there are elements that must be part of the analysis regardless of the chosen approach. This paper offered clarifications on the foundations of a DSA and the elements that constitute it.

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